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INVESTIGATION REPORT

PRELIMINARY GROUNDWATER CONTAMINATION ASSESSMENT

ORCHARD KNOLL SITE

Albion, Michigan

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Prepared for:

**MICHIGAN DEPARTMENT
OF NATURAL RESOURCES**

**CONTRACT NUMBER 6624
PROJECT NUMBER 6792-01**

MARCH 1993

ABB Environmental Services, Inc.

ABB
ASEA BROWN BOVERI

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Prepared by:

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March 1993

PRELIMINARY GROUNDWATER CONTAMINATION ASSESSMENT REPORT
ORCHARD KNOLL SITE
Albion, Michigan

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1.0 EXECUTIVE SUMMARY

The Orchard Knoll site is located in the city of Albion, Sheridan Township, Calhoun County, Michigan. In 1988 and 1989, several residential and commercial water wells near the site were found to be contaminated with low concentrations of volatile organic compounds (VOCs). As a result, State funding was used to extend the municipal water system to serve the affected area, and the contaminated wells were abandoned.

In 1991, the Michigan Department of Natural Resources (MDNR) requested ABB Environmental Services, Inc. (ABB-ES) to conduct an investigation at the site to identify (to the extent practicable) the source(s) of the contaminants discovered in the water wells. To accomplish this objective, a phased approach for the Orchard Knoll project was developed. The initial phase summarized what was known about the site based on currently available information. This information was summarized in a report entitled, "Current Site Description, Orchard Knoll Groundwater Contamination, Albion, Michigan (February 1992)."

The second phase, the subject of this report, was a field investigation designed to assess groundwater conditions in the immediate area of the contaminated water wells. During Phase II, ABB-ES installed and sampled four monitoring wells located between the contaminated water wells and several nearby potential sources of contamination. The monitoring wells were screened at elevations similar to the contaminated water wells. Soil samples were also collected during drilling to characterize the geologic conditions in the immediate area, and piezometric surface elevations were measured to assess groundwater flow directions.

The field investigation revealed that the unconsolidated materials at the site consist primarily of sand and gravel with some silt and clay to depths ranging from 50 to 80 feet. A confined aquifer exists in the glacial deposits which may be hydraulically connected to the Marshall Sandstone aquifer, the primary source of groundwater supplies in the area. Water level measurements in four monitoring wells installed in the uppermost part of the sandstone aquifer indicate that groundwater in the sandstone aquifer is flowing west toward a pumping center at the McGraw Edison facility.

The presence of groundwater contamination in the vicinity of Orchard Knoll Street was not

confirmed by the results of this investigation. VOCs were not present in groundwater samples collected from the four monitoring wells installed in Phase II. Similarly, observations by ABB-ES' field geologist during the drilling and sampling program did not suggest the presence of VOCs in groundwater above the sandstone aquifer. The source of the contaminants found in well water samples collected from residences on Orchard Knoll remains unknown. However, the Albion-Sheridan Township dump is located immediately upgradient from the Orchard Knoll site.

2.0 INTRODUCTION

2.1 PROJECT BACKGROUND

The Orchard Knoll site is located in the city of Albion, Sheridan Township (T2S, R4W, Section 36), Calhoun County, Michigan (see Figure 2-1). Between 1988 and 1989, samples from several water-supply wells serving residences located on Orchard Knoll Street and adjacent streets were found to be contaminated with various volatile organic compounds (VOCs). The contaminated wells have since been abandoned and sealed, and these homes are now served by the Albion municipal water system.

In response to the discovery of groundwater contamination at the site, the Michigan Department of Natural Resources (MDNR) requested ABB Environmental Services, Inc. (ABB-ES) to conduct an environmental investigation to identify (to the extent practicable) the source(s) of the contaminants. To accomplish this objective, ABB-ES developed a phased approach to the project. In Phase I, ABB-ES compiled and interpreted the information available on the hydrogeology of the site, the apparent distribution of contaminants in groundwater, and the locations of potential contamination sources. The results of this effort were summarized in ABB-ES' Phase I report entitled, "Current Site Description, Orchard Knoll Groundwater Contamination, Albion, Michigan (February 1992)." The reader is referred to the previous report for a discussion of the historical data.

Based on the results of the information review, MDNR and ABB-ES designed Phase II: a preliminary field investigation to assess the magnitude and extent of contamination in the immediate area of the contaminated water wells. The Phase II field investigation was also designed to collect additional information on local geologic conditions and groundwater flow patterns at the site. This report documents the findings of the preliminary field investigation.

2.2 OBJECTIVES

Three primary objectives were identified by MDNR and ABB-ES prior to developing the Scope of Work for the Orchard Knoll Site Preliminary Groundwater Contamination Assessment. These objectives are as follows:

FIGURE 2-1
SITE LOCATION MAP
ORCHARD KNOLL SITE
ALBION, MICHIGAN

- 1) Confirm the presence of groundwater contamination in the sandstone aquifer at the site;
- 2) Evaluate the direction of groundwater flow in the shallow sandstone aquifer near the contaminated residential wells on Orchard Knoll Street; and
- 3) Assess the glacial stratigraphy at the site and evaluate its role in contaminant migration.

The following sections summarize the activities conducted during the investigation to meet these objectives.

2.3 SCOPE OF WORK

A total of eight tasks were conducted during the Orchard Knoll Preliminary Groundwater Contamination Assessment. These tasks were further divided into an Initial Activities sub-phase and a Field Investigation sub-phase as follows:

INITIAL ACTIVITIES

- Task 1: Quality Assurance Project Plan Preparation
- Task 2: Health and Safety Plan Preparation
- Task 3: Site Preparation

FIELD INVESTIGATION

- Task 4: Geologic Reference Sampling/Monitoring Well Installation
- Task 5: Groundwater Sampling
- Task 6: Analytical Program
- Task 7: Data Evaluation
- Task 8: Report Preparation

The methods used by ABB-ES and the results of these activities are described in the following sections.

3.0 SITE INVESTIGATION

3.1 INITIAL ACTIVITIES

The Initial Activities tasks completed by ABB-ES are briefly described in Section 3.1 of this report. A more detailed description of these activities is presented in ABB-ES' Final Work Plan for the project (May 1992).

3.1.1 Task 1: Prepare Quality Assurance Project Plan

Prior to the collection and analysis of environmental samples, a Quality Assurance Project Plan (QAPP) was prepared to ensure that valid and appropriate methods were consistently applied toward achieving project objectives. The QAPP described the quality assurance/quality control (QA/QC) procedures to be used in the collection and analysis of samples, the generation of data, and the assessment of data. The QAPP followed guidelines established by the USEPA and was approved by the MDNR prior to on-site sampling activities.

3.1.2 Task 2: Prepare Health and Safety Plan

Prior to initiation of site characterization activities, a site-specific Health and Safety Plan (HASP) was developed by ABB-ES to assess the potential hazards to project staff and the public associated with the Orchard Knoll site investigation. The HASP was based on a review of available data concerning the types and amounts of chemical compounds likely to be found at the site. This assessment concluded that Level D personal protection measures would be adequate for field work in the study area. The HASP was designed to be modified as necessary to account for new information obtained during the field investigation.

3.1.3 Task 3: Establish Site Facilities

Because of the short duration of the field program and the minimal amount of supplies required for the field work, ABB-ES did not establish a site trailer on site. Health and safety supplies and sampling equipment were kept in the site geologist's field vehicle. However, to comply with federal

regulations for sanitation at hazardous waste sites, a portable toilet was established at the site.

3.2 FIELD INVESTIGATION

Following each field task, a detailed memorandum was written to document (in detail) the procedures used and data obtained during the task. These technical memoranda are as follows:

Technical Memorandum No. 1: Geologic Reference Sampling/Monitoring Well Installation

Technical Memorandum No. 2: Groundwater Sampling and Analysis

The reader is referred to these technical memoranda (located in Appendices A and B, respectively) for detailed descriptions of the methods and results of each of these tasks.

3.2.1 Task 4: Geologic Reference Sampling/Monitoring Well Installation

To assess the site's glacial stratigraphy and bedrock geology, five borings (GRS-1, -2, -3, -4 and -4A) were completed in the bedrock aquifer at depths ranging from 83 to 110 feet (Figure 3-1). During drilling, soil samples were collected at 5-foot intervals from the ground surface to the bedrock surface, with the exception of GRS-4A, which was not sampled for soils. Bedrock was encountered at depths ranging from 52 to 84 feet below grade. Three of the borings (GRS-2, GRS-3, and GRS-4) were advanced into the bedrock by water-rotary drilling, and two borings (GRS-1 and GRS-4A) were advanced by rock coring. Groundwater monitoring wells were installed in four of the five borings; GRS-4 was abandoned by backfilling with bentonite slurry. Because no indication of VOCs was noted during the drilling and sampling program, the monitoring wells were screened at the same approximate elevation as the contaminated water wells. To permit the construction of groundwater flow maps based on groundwater level measurements in the monitoring wells, ABB-ES retained a state-licensed surveying firm to measure the casing elevations of the four newly-installed monitoring wells.

A detailed description of the drilling and installation methods is included in Technical Memorandum No. 1 (see Appendix A).

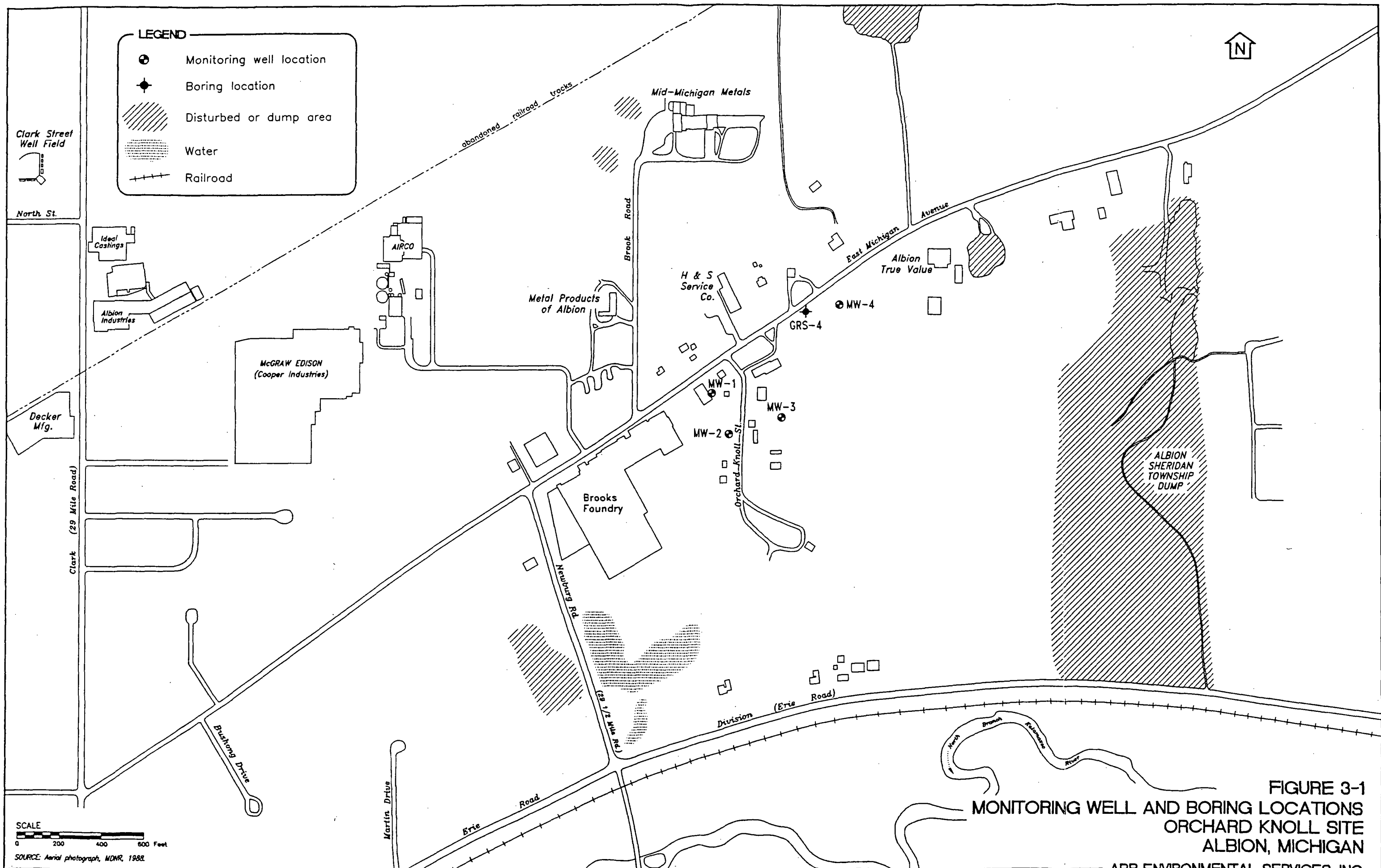


FIGURE 3-1
MONITORING WELL AND BORING LOCATIONS
ORCHARD KNOLL SITE
ALBION, MICHIGAN

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3.2.2 Task 5: Groundwater Sampling

Approximately one week after well installation, ABB-ES collected groundwater samples from the four new monitoring wells. Prior to sampling, an electronic water-level indicator was used to measure piezometric levels and well depths to the nearest 0.01 feet. After purging stagnant groundwater from the well casing, a groundwater sample was collected from each well using a bailer. Samples were collected in accordance with the QAPP. Trip blank, sampler blank, blind duplicate, and matrix spike/matrix spike duplicate (MS/MSD) samples were also submitted to the laboratory for analysis with the site samples. The sampling program is described in Technical Memorandum No. 2 (see Appendix B).

3.2.3 Task 6: Analytical Program

Groundwater samples collected by ABB-ES were submitted to Coast-to-Coast Analytical Laboratory in Valparaiso, Indiana, for analysis of VOCs using USEPA Methods 8010 and 8020. Analytical results are summarized in Technical Memorandum No. 2 (see Appendix B).

3.2.4 Task 7: Data Evaluation

To facilitate data interpretation, ABB-ES reviewed the analytical results provided by the laboratory to verify that the applicable quality control requirements had been met and to evaluate the potential for bias in the reported results. Data were evaluated based on holding times, blank analysis results, surrogate compound recoveries, and MS/MSD sample results. The results of this evaluation were incorporated into the data tables included in Technical Memorandum No. 2 (see Appendix B).

4.0 SITE CHARACTERIZATION

4.1 HYDROGEOLOGIC SETTING

This section of the report summarizes the information collected during ABB-ES' field investigation at the Orchard Knoll site. The reader is referred to ABB-ES' "Current Site Description" report for a general discussion of the regional and local hydrogeologic conditions near the site.

The unconsolidated deposits at the site consist primarily of sands, gravels, silts, and clays of glacial and fluvial origin. The glacial deposits are primarily tills, the results of moraines left by retreating glaciers, and outwash sands and gravels deposited by glacial melt waters. The surficial bedrock in the area is the Marshall Sandstone formation, which consists of sandstone interbedded with siltstone layers. This formation is a major source of groundwater supplies for water wells in the region. Based on drilling the five borings at the site, the top of the sandstone bedrock appears to be highly fractured.

Figure 4-1 is a generalized geologic cross section of the site based on the five borings completed by ABB-ES. The thickness of the unconsolidated deposits at the site ranges from approximately 50 to 80 feet. These deposits generally consist of 35 to 45 feet of sand and gravel overlying a clayey-silt layer approximately 5 to 10 feet thick that appears to be continuous across the site. Beneath the clayey-silt unit is a basal sand-and-gravel deposit that ranges in thickness from approximately 10 to 30 feet. This lower sand-and-gravel unit is likely to be hydraulically connected to the underlying Marshall Sandstone Formation, especially with the top of bedrock being fractured.

Groundwater is encountered at depths ranging from 30 to 40 feet below grade, at or near the elevation of the clayey-silt unit. As a result, the uppermost sand-and-gravel deposit is unsaturated in most places (except in the area of MW-4), and the basal sand-and-gravel aquifer is under confined conditions across much of the site.

The piezometric surface for the sandstone aquifer, based on water levels measured in the four monitoring wells installed during this investigation, is shown in Figure 4-2. The direction of groundwater flow in the upper part of the sandstone aquifer at the Orchard Knoll site is generally

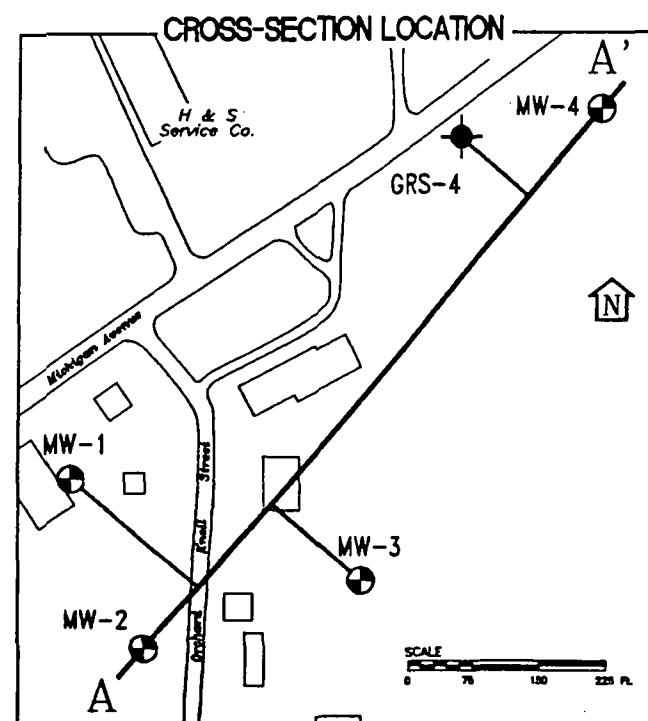
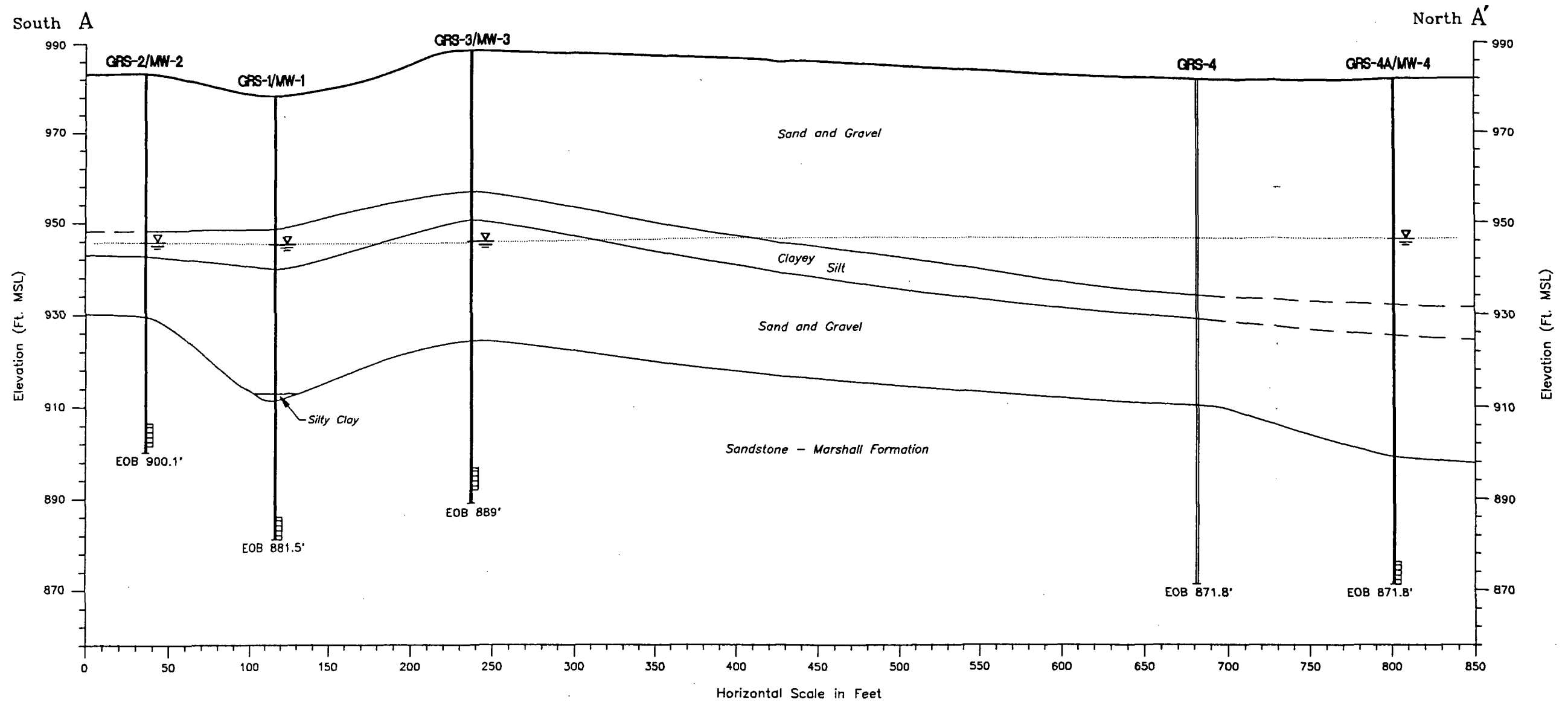


FIGURE 4-1
GENERALIZED GEOLOGIC CROSS-SECTION A-A'
ORCHARD KNOLL SITE
ALBION, MICHIGAN

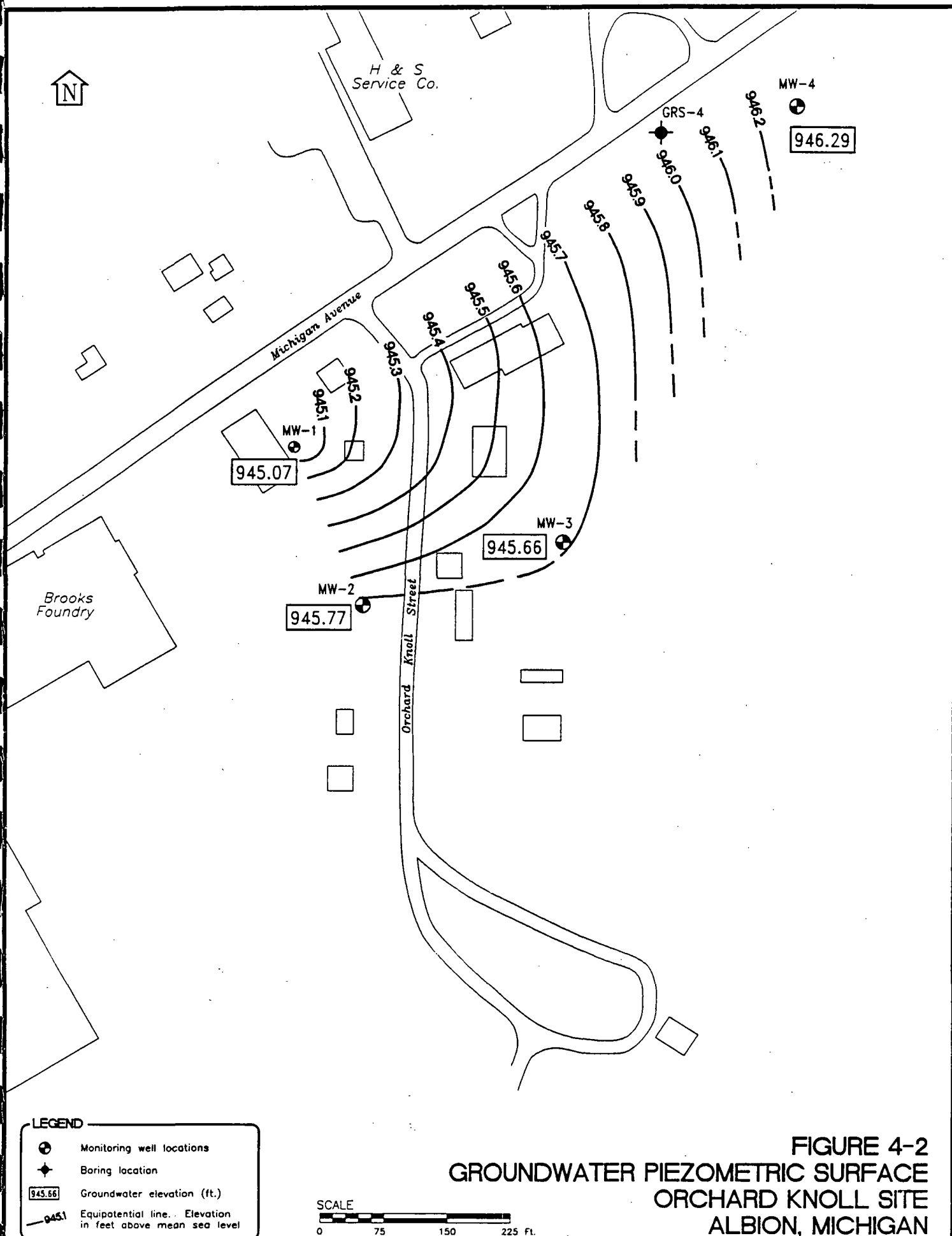


FIGURE 4-2
GROUNDWATER PIEZOMETRIC SURFACE
ORCHARD KNOLL SITE
ALBION, MICHIGAN

west toward the pumping center created by a groundwater removal and treatment system at the McGraw Edison facility (located approximately 0.35 miles west of Orchard Knoll Street).

4.2 GROUNDWATER CONTAMINATION ASSESSMENT

In previous sampling, the MDPH identified two chlorinated VOCs (1,1-dichloroethane and 1,1,1-trichloroethane) and two freon compounds (fluorotrichloromethane and dichlorofluoromethane). The MDPH also reported low concentrations of three aromatic hydrocarbons, ethylbenzene, toluene, and xylene, sporadically in samples from the contaminated water wells on Orchard Knoll Street.

Chlorinated VOCs are often present in solvents associated with industrial processes (e.g., metal degreasers, paint removers) or are produced as chemical intermediates. Some chlorinated aliphatics (e.g., dichloroethene and dichloroethane compounds) may be produced in the environment through the degradation of the common industrial solvents 1,1,1-trichloroethane, trichloroethene, and tetrachloroethene. The freon compounds are used primarily as refrigerants. The aromatic hydrocarbons can be associated with a large number of activities and industrial processes including petroleum products (e.g., gasoline) and paints.

As shown in Table 4-1, the groundwater samples collected by ABB-ES from the four newly installed monitoring wells contained no VOCs. Observations by ABB-ES' field geologist during the drilling and sampling program also did not suggest the presence of VOCs in groundwater above the screened intervals in those locations.

TABLE 4-1
ORCHARD KNOLL INVESTIGATION
LABORATORY RESULTS FOR GROUNDWATER SAMPLES
AUGUST 1992

Sample Location:		MW-01	MW-02	MW-03	MW-101	MW-04	MW-201	TB-01
		Dup of MW-03				Sampler Blank Trip Blank		
<u>Volatile Organics</u>	<u>Units</u>							
1,1,1-Trichloroethane (TCA)	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2,2-Tetrachloroethane	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2-Trichloroethane	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichlorobenzene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane (EDC)	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloropropane	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
2-Chloroethylvinylether	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Bromodichloromethane	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromoform	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromomethane	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Carbon Tetrachloride	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chlorobenzene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloroethane	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Chloroform	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloromethane	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Methylene Chloride	µg/L	5 U	5 U	5 U	5 U	5 U	15	5 U
Tetrachloroethene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichloroethene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichlorofluoromethane	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Vinyl Chloride	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U
cis-1,3-Dichloropropene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,2-Dichloroethene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,3-Dichloropropene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichlorobenzene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Benzene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chlorobenzene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Xylenes	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U

Notes: U - Undetected. The analyte was analyzed for but not detected; the associated value shown is the Practical Quantitation Limit (PQL).
- Contaminants detected are shaded.

5.0 CONCLUSIONS

1. The unconsolidated deposits at the Orchard Knoll site generally consist of 35 to 45 feet of sand and gravel overlying a clayey-silt layer approximately 5 to 10 feet thick that appears to be continuous across the site. Beneath the clayey-silt unit is a basal sand-and-gravel deposit that ranges in thickness from approximately 10 to 30 feet. This lower sand-and-gravel unit is likely to be hydraulically connected to the underlying Marshall Sandstone Formation which is a major source of water supplies for the area. The contaminated water-supply wells reported by the MDPH are thought to be finished in the uppermost part of the Marshall Sandstone aquifer.

Groundwater was encountered at depths ranging from 30 to 40 feet below grade, at or near the elevation of the clayey-silt unit. As a result, the uppermost sand-and-gravel deposit is unsaturated in most places (except in the area of MW-4), and the basal sand-and-gravel aquifer is under confined conditions across much of the site.

2. The direction of groundwater flow in the upper part of the Marshall Sandstone aquifer at the Orchard Knoll site is generally west toward a pumping center created by a groundwater removal and treatment system at the McGraw Edison facility (located approximately 0.35 miles west of Orchard Knoll Street). At this time, it appears that the only potential source of groundwater contamination located immediately upgradient (east) of the Orchard Knoll site is the Albion-Sheridan Township dump.

Locally, groundwater flow directions near Orchard Knoll may vary in response to changes in the operating schedule for this groundwater withdrawal system. Similarly, prior to the installation of the McGraw-Edison groundwater recovery system, groundwater flow patterns near Orchard Knoll Street may have differed from those measured in September 1992 by ABB-ES.

3. The presence of groundwater contamination in the vicinity of Orchard Knoll Street was not confirmed by the results of this investigation. Groundwater samples collected from monitoring wells in close proximity to Orchard Knoll Street, and screened in the Marshall Sandstone aquifer at elevations similar to the contaminated water wells on Orchard Knoll,

contained no VOCs. Observations by ABB-ES' field geologist during the drilling and sampling program also did not suggest the presence of VOCs in groundwater above the Marshall Sandstone.

REFERENCES

ABB-ES Services, Inc. February, 1992. "Current Site Description Report" prepared for the Michigan Department of Natural Resources.

ABB-ES Services, Inc. May 1992. "Work Plan, Preliminary Groundwater Contamination Assessment" prepared for the Michigan Department of Natural Resources.

ABB-ES Services, Inc. July 1992. "Quality Assurance Project Plan" prepared for the Michigan Department of Natural Resources.

APPENDIX A

**TECHNICAL MEMORANDUM NO.1
GEOLOGIC REFERENCE SAMPLING/MONITORING WELL INSTALLATION
ORCHARD KNOLL GROUNDWATER CONTAMINATION ASSESSMENT**

TECHNICAL MEMORANDUM NO.1

PROJECT: Orchard Knoll Site (Albion, Michigan)
Preliminary Groundwater Contamination Assessment

SUBJECT: Geologic Reference Sampling/Monitoring Well Installation

PREPARED BY: Kelly L. Mish/ABB Environmental Services, Inc.

INTRODUCTION

The purpose of this technical memorandum is to describe the geologic reference sampling and monitoring well installation conducted as Task 4 of the Work Plan during the Orchard Knoll Site Preliminary Groundwater Contamination Assessment. These activities were conducted by ABB Environmental Services, Inc. (ABB-ES) for the Michigan Department of Natural Resources (MDNR), Jackson District, under Contract No. 6624. This task was generally performed as described in the Orchard Knoll Site Work Plan (May 1992) and the Quality Assurance Project Plan (August 1992). The data generated during this task will be used to evaluate the presence of groundwater contamination in the Orchard Knoll study area and to assess hydrogeologic conditions in the immediate vicinity of the site.

SCHEDULE

The activities described in this memorandum were conducted from August 4 through September 9, 1992.

PERSONNEL

The drilling, sampling, and monitoring well installation program was conducted by the following associates from ABB-ES and its drilling subcontractor, Mateco Drilling Company (Mateco):

ABB-ES

Kelly Mish (Geologist)
Rick Dunkin (Site Manager)

Mateco

Gregory Sawyer (Driller)
Thomas Green (Drilling Assistant)
Vince Bennett (Field Supervisor)

FIELD PROCEDURES

A total of five geologic reference borings were drilled at the Orchard Knoll site. The geologic reference borings are identified by the descriptor "GRS" followed by the boring location number (e.g. GRS-2). Monitoring wells installed in the geologic reference borings are identified by the descriptor "MW" followed by the boring location number (e.g. MW-2). Groundwater monitoring wells were installed in all of the geologic reference borings except one (GRS-4). Difficult drilling conditions resulted in the loss of down-hole drilling tools in the bedrock at GRS-4. This drilling location was abandoned after an unsuccessful attempt to recover the drilling tools. A replacement boring (GRS-4A) was subsequently drilled, and monitoring well MW-4 was installed in this borehole.

The following sections describe the procedures used in the field at the Orchard Knoll site during geologic reference sampling, bedrock drilling, monitoring well installation, decontamination, management of waste materials generated during the site investigation, and surveying.

Geologic Reference Sampling

The unconsolidated glacial drift was drilled using 6.25-inch-ID hollow-stem augers at each of the five locations. During drilling, soil samples were collected at 5-foot intervals in 2-foot-long split-spoon samplers from the ground surface to the top of the bedrock (approximately 52 to 70 feet below grade) in all of the borings except for GRS-4A (the replacement boring for GRS-4). The samples were visually examined and their characteristics recorded using the Unified Soil Classification System. Soil descriptions for GRS-4A were based on cuttings brought to the surface by the auger flights.

The soil samples from each boring were screened on-site for total volatile organic compounds (VOCs) using a photoionization (PI) meter. The PI meter was used to scan each soil sample immediately upon opening the split-spoon sampler. Later, the PI meter was used to measure total VOCs in the headspace of the glass sample jar.

After sampling the glacial drift, a 4-inch-ID, flush-joint casing equipped with a diamond cutting tip was lowered through the augers and rotated a short distance into the bedrock. At three of the boring locations (GRS-2, GRS-3 and GRS-4), water-rotary drilling was used to advanced the borings approximately 30

feet into the bedrock. Bedrock chips (cuttings) were circulated to the surface and visually examined for lithology, color, grain size, and other pertinent information. At the other two drilling locations (GRS-1 and GRS-4A), wireline coring equipment was used to advance the borings approximately 30 feet into bedrock. The rock cores were visually examined and their characteristics recorded (e.g., lithology, color, grain size, sedimentary structures). The following section describes in detail the bedrock drilling activities.

Bedrock Drilling and Coring

Difficult drilling conditions (fractured and incompetent sandstone bedrock) were frequently encountered while drilling into the sandstone aquifer at the Orchard Knoll site. Circulation of the drilling fluids (i.e., water) was lost in one or more intervals at each of the boring locations. A detailed description of the bedrock drilling/coring methods used at each boring location is presented in the following paragraphs.

The HQ wireline core system was used to advance borings GRS-1 and GRS-4A approximately 30 feet into the bedrock. Water circulation was lost to the formation while coring each borehole; however, no other significant drilling problems were encountered in either boring.

Water-rotary drilling was used to drill GRS-2 approximately 30 feet into the bedrock. Fractured and incompetent sandstone bedrock was encountered in the uppermost 10 feet of the sandstone aquifer, and large volumes of water were lost to the formation while drilling in this zone. In addition, the continuous collapse of incompetent sandstone into the borehole while drilling in this zone almost resulted in the drill rods becoming sand locked. To prevent this, the 4-inch temporary casing was advanced an additional 10 feet into the bedrock to case off the zone of incompetent sandstone. Water-rotary drilling was then used to drill an additional 20 feet into the bedrock.

At GRS-3, the HQ casing-advancer system (with water as the drilling fluid) was used to rotary drill approximately 30 feet into the bedrock. The HQ casing advancer system was used to help prevent the borehole from collapsing while drilling through fractured, incompetent sandstone layers. No significant problems were encountered while drilling this boring.

The HQ casing advancer system (with water as the drilling fluid) was used to rotary drill 23 feet into the

bedrock at GRS-4. Fractured, incompetent, sandstone bedrock was encountered throughout this interval. Large volumes of water were lost into the formation, and incompetent sandstone continuously collapsed while drilling through the bedrock. The 4-inch temporary casing was advanced 14 additional feet to case off the fractured, incompetent sandstone. The casing advancer, connecting sub, and roller bit were lost in the borehole at a depth of approximately 91 feet below grade. Mateco made several unsuccessful attempts to retrieve the lost drilling equipment by reaming the hole with the temporary casing and with hollow-stem augers. The borehole was abandoned by pumping a dense bentonite slurry through a tremie line into the temporary casing and augers. The temporary casing and augers were then pulled from the borehole while the slurry was pumped, filling the borehole to the ground surface.

Monitoring Well Installation

A total of four monitoring wells, ranging in depth from 82 to 110 feet, were installed at the Orchard Knoll site. Each monitoring well was constructed of 2-inch-ID, flush-threaded, galvanized-steel well casing and a 5-foot-long, continuous-slot, stainless-steel screen with 0.01-inch slot openings. A coarse silica-sand filter pack was placed in the annulus from the bottom of the screen to approximately 2 feet above the top of the screen. Approximately 1 foot of fine silica sand was placed above the coarse sand pack.

After placing the well screen and filter pack in GRS-1/MW-1 and GRS-2/MW-2, a dense bentonite slurry was pumped through a tremie pipe into the annular space between the well casing and the augers from the top of the sand filter pack to within a few feet of the ground surface. Several hundred gallons of dense bentonite slurry were lost into the formation at approximately 63 to 65 feet below grade while completing GRS-2/MW-2.

In GRS-3/MW-3 and GRS-4A/MW-4, a dense bentonite slurry was pumped through a tremie pipe into the annular space between the well casing and the augers from the top of the sand filter pack to a depth of 70 and 55 feet below grade, respectively. The remaining annular space in MW-3 and MW-4 was grouted with a bentonite/cement grout to within a few inches of the ground surface.

Lockable well protectors were then cemented in place flush with the ground surface at MW-1 and MW-3. Above-grade lockable steel well protectors were cemented in place at MW-2 and MW-4.

All monitoring wells were developed using a modified surge block to surge the well screen area and remove groundwater and sediment from the well. After surging the well screen, a bailer was used to remove excess sand and silt, and the well was overpumped with a Grundfos submersible pump. Each well was developed until the water was free of fine-grained sediment.

Decontamination

Down-hole sampling and drilling equipment was decontaminated before drilling began and between borings using a high-pressure steam cleaner. Split-spoon samplers were decontaminated between samples with a TSP and distilled water solution and then rinsed with distilled water. Well development equipment was decontaminated before its initial use and between wells using a high-pressure steam cleaner.

Management of Site-Investigation Generated Materials

In accordance with MDNR's standard practices and directions, groundwater and soil cuttings were not containerized because total VOC (PI meter) readings in air at the work location did not exceed 1 part per million above the ambient air background concentrations. Drilling spoils from well installation were spread out such that they did not create a nuisance. Development water, purge water, and decontamination water were allowed to discharge to the ground at each location.

Surveying

Ingersoll, Watson & McMachen, Inc., a state-registered surveying company, surveyed the ground surface and top-of-casing elevations of the four wells. Elevations were referenced to mean sea level (MSL) using a USGS benchmark located near the intersection of East Erie and Mingo streets in Albion, Michigan (monument was stamped 1916 11-C). Casing elevations were measured from the northern side of each well to the nearest 0.01 feet. Horizontal locations were measured to the nearest foot from the Michigan Department of Transportation control datum for Michigan Avenue in Albion, Michigan.

RESULTS

Detailed boring logs and well-construction diagrams are attached to this technical memorandum. Figure

TM1-1 shows the location of the monitoring wells. Table TM1-1 summarizes the monitoring well completion data.

TABLE TM1-1
ORCHARD KNOLL SITE INVESTIGATION
WELL COMPLETION DATA

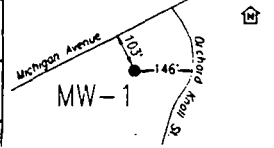
WELL DESIGNATION	DATE COMPLETED	WELL DEPTH BELOW GROUND SURFACE (FT)	GROUND SURFACE ELEVATION (FT)	TOP OF CASING ELEVATION (FT)
MW-1	8/6/92	95	976.5	976.26
MW-2	8/14/92	83	983.1	985.16
MW-3	8/23/92	99	988.0	987.89
MW-4	9/3/92	110	981.8	984.47

NOTES:

1. All elevations in feet referenced to an on-site survey benchmark and USGS datum.
2. All wells constructed of 2-inch-ID, flush-threaded, galvanized riser pipe and .010-inch slotted, 5-foot-long stainless-steel screen.

BORING LOGS

PROJECT NO.: 6792-01		PROJECT NAME: MDNR - ORCHARD KNOLL		BORING/WELL DESIGNATION: : GRS-1/MW-1		BORING/WELL LOCATION:	
DRILLING CONTRACTOR: MATECO DRILLING CO.		DRILLING METHOD: SEE NOTES		BOREHOLE SIZE: 11 IN.		BOREHOLE DEPTH: 95 FT.	
DATE STARTED: 8/04/92		DATE COMPLETED: 8/06/92		GROUND ELEV.: 976.5 FT.		MEASURING POINT ELEV: 976.26 FT.	
RIG: CME-75		DRILLER: G. SAWYER		HELPER: T. GREEN		LOGGED BY: K. MISH	



DEPTH (FT.)	DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNTS(N)	PI METER	COMMENTS	WELL DATA
0						WELL COMPLETED AT GRADE WITH A FLUSH-MOUNT STEEL WELL PROTECTOR SET IN CONCRETE	
	SAND - brown, medium grained, trace fine gravel, moderate-well sorted, loose, damp					CONCRETE	- X X X
5	SAND - light brown/tan, medium grained, trace coarse grained and fine gravel, poorly graded, very loose, damp	4-6'	SS	2-2-2-2	ND	CHUNK BENTONITE	
10		9-11'	SS	1-2-4-6	ND	2-INCH FLUSH-THREADED GALVANIZED-STEEL RISER PIPE	
15		14-16'	SS	2-4-7-7	ND		
20	SAND - light brown, medium grained, trace gravel, poorly graded, medium dense, damp (gravel at 20.8 to 21 feet)	19-21'	SS	4-8-12-15	ND	DENSE BENTONITE SLURRY	
25	(groundwater at 24 feet)	24-26'	SS	4-5-6-8	ND		
30	SILT - gray, trace clay and sand, dense, wet	29-31'	SS	8-8-8-10	ND		

- NOTES:
1. SS - SOIL COLLECTED WITH A SPLIT-SPOON SAMPLER.
 2. ND - NOT DETECTED.
 3. "DRILLING METHOD" - 6.25-INCH ID HOLLOW-STEM AUGERS TO BEDROCK AND 3.5-INCH ID HQ WIRELINE CORE SYSTEM FROM BEDROCK TO DEPTH.
 4. MEASURING POINT ELEVATION - TOP OF INNER CASING.
 5. "P.I. METER" - HEADSPACE SCREENING USING A PHOTOIONIZATION METER, EXPRESSED IN PPM.

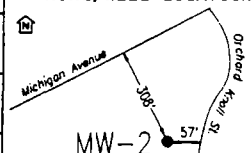
PROJECT NO.: 6792-01		PROJECT NAME: MDNR - ORCHARD KNOLL		BORING/WELL NUMBER: GRS-1/MW-1		BOREHOLE DEPTH: 95 FT.	
DEPTH (FT.)	DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNTS(N)	PI METER	COMMENTS	WELL DATA
30	SILT (continued)	29-31'	SS	8-8-8-10	ND		
35	SILTY CLAY - gray, stiff, moist	34-36'	SS	4-5-9-10	ND		
40	SAND - brown, fine-medium grained, little silt and clay, trace gravel, very loose-dense, wet	39-41'	SS	WOH-WOH-2-2	ND	DENSE BENTONITE SLURRY	
45		44-46'	SS	WOR-WOR-WOH-1	ND		
50	(drilling indicates cobbles at 49 to 53 feet)	49-51'	SS	30-7-7-27	NR		
55		54-56'	SS	9-16-21-9	ND	2-INCH FLUSH-THREADED GALVANIZED-STEEL RISER PIPE	
60		59-60'	SS	51-46-X-X	NR		
65	SILTY CLAY - gray, sandstone fragments, damp-moist	64-65'	SS	64-56-X-X	NR	REDUCED BOREHOLE DIAMETER FROM 11 INCHES TO 4 INCHES AT 65 FEET	
70	SANDSTONE - light gray, fine grained, some medium grained, friable, fractured, wet, MARSHALL FORMATION						

NOTES: 1. SS - SOIL COLLECTED WITH A SPLIT-SPOON SAMPLER. 2. ND - NOT DETECTED. 3. NR - NOT RECORDED.
 4. "DRILLING METHOD" - 6.25-INCH ID HOLLOW-STEM AUGERS TO BEDROCK AND 3.5-INCH ID HQ WIRELINE CORE SYSTEM FROM BEDROCK TO DEPTH.
 5. WOH - WEIGHT OF HAMMER. 6. WOR - WEIGHT OF RODS. 7. X - SAMPLE REJECTION.

PROJECT NO.: 6792-01		PROJECT NAME: MDNR - ORCHARD KNOLL		BORING/WELL NUMBER: GRS-1/MW-1		BOREHOLE DEPTH: 95 FT.	
DEPTH (FT.)	DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNTS(N)	PI METER	COMMENTS	WELL DATA
70	SANDSTONE - light gray, fine grained, some medium grained, friable, fractured, wet						
75						DENSE BENTONITE SLURRY	
80						2-INCH FLUSH-THREADED GALVANIZED-STEEL RISER PIPE	
85						SAND FILTER PACK	
90						2-INCH 10-SLOT WIRE-WOUND STAINLESS-STEEL WELL SCREEN	
95	END OF BORING AT 95 FEET						

NOTES: 1. SS - SOIL COLLECTED WITH A SPLIT-SPOON SAMPLER. 2. ND - NOT DETECTED.
 3. "DRILLING METHOD" - 6.25-INCH ID HOLLOW-STEM AUGERS TO BEDROCK AND 3.5-INCH ID HQ WIRELINE CORE
 SYSTEM FROM BEDROCK TO DEPTH.
 4. MEASURING POINT ELEVATION - TOP OF INNER CASING.

PROJECT NO.: 6792-01		PROJECT NAME: MDNR - ORCHARD KNOLL		BORING/WELL DESIGNATION: GRS-2/MW-2		BORING/WELL LOCATION:	
DRILLING CONTRACTOR: MATECO DRILLING CO.		DRILLING METHOD: SEE NOTES		BOREHOLE SIZE: 8 IN.		BOREHOLE DEPTH: 83 FT.	
DATE STARTED: 8/6/92		DATE COMPLETED: 8/14/92		GROUND ELEV.: 983.1 FT.		MEASURING POINT ELEV: 985.16 FT.	
RIG: CME-75		DRILLER: G. SAWYER		HELPER: T. GREEN		LOGGED BY: K. MISH	



DEPTH (FT.)	DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNTS(N)	P.I. METER	COMMENTS	WELL DATA
					(ppm)		
0	TOPSOIL					WELL COMPLETED ABOVE GROUND WITH A LOCKABLE WELL PROTECTOR	
	SAND - brown, medium grained, trace gravel and clay, poorly graded, loose, damp-moist					CONCRETE	X X X X X X
5		4-6'	SS	1-2-4-5	ND		
	SAND - light brown, medium grained, trace fine sand and gravel, poorly graded, loose-dense, damp-moist						
10		9-11'	SS	2-4-5-8	ND	2-INCH FLUSH-THREADED GALVANIZED-STEEL RISER PIPE	
15		14-16'	SS	3-5-7-10	ND		
20		19-21'	SS	4-5-6-9	ND	DENSE BENTONITE SLURRY	
25	GRAVELLY SAND - light brown, fine-coarse grained, poorly graded, loose, damp-moist	24-26'	SS	5-17-23-25	ND		
30		29-31'	SS	5-20-35-40	ND		

- NOTES: 1. SS - SOIL COLLECTED WITH A SPLIT-SPOON SAMPLER.
 2. ND - NOT DETECTED.
 3. "DRILLING METHOD" - 4.25-INCH ID HOLLOW-STEM AUGERS, WATER-ROTARY, AND CASING ADVANCER.
 4. MEASURING POINT ELEVATION - TOP OF INNER CASING.
 5. "P.I. METER" - HEADSPACE SCREENING WITH A PHOTOIONIZATION METER, EXPRESSED IN PPM.

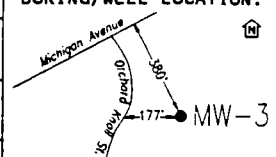
PROJECT NO.: 6792-01		PROJECT NAME: MDNR - ORCHARD KNOLL		BORING/WELL NUMBER: GRS-2/MW-2		BOREHOLE DEPTH: 83 FT.	
DEPTH (FT.)	DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNTS(N)	PI METER	COMMENTS	WELL DATA
30	GRAVELLY SAND (continued)	29-31'	SS	5-20-35-45	ND		
	(drilling indicates cobbles at 32 to 36 feet)						
	(groundwater at 34 feet)						
35	NO RECOVERY	34-36'	SS	17-19-20-28	NR		
	CLAYEY SILT - gray, trace sand, stiff-very stiff, moist-wet	36.5-38.5'	SS	2-4-7-9	ND		
40	SILTY CLAY - gray, wet	39-41'	SS	4-10-18-27	ND	2-INCH FLUSH-THREADED GALVANIZED-STEEL RISER PIPE	
	SAND - brown, medium grained, trace gravel, silt and clay, moderately graded, medium dense, wet						
45		44-46'	SS	27-11-12-18	ND		
	SAND, GRAVEL AND SILTY CLAY - brown, fine-medium sand, fine-coarse gravel, well graded, wet						
50	SANDY CLAY - gray, fine grained, little silt, trace medium sand and gravel, stiff, damp	49-51'	SS	6-6-6-7	ND		
	SANDSTONE - light gray, medium grained, micaceous, poorly graded, fractured, wet, MARSHALL FORMATION						
55		54-56'	SS	17-30-31-18	ND	REDUCED BOREHOLE DIAMETER FROM 8-INCH TO 4-INCH	
60							
65						DENSE BENTONITE SLURRY	
70							

- NOTES: 1. SS - SOIL COLLECTED WITH A SPLIT-SPOON SAMPLER.
 2. ND - NOT DETECTED.
 3. "DRILLING METHOD" - 4.25-INCH ID HOLLOW-STEM AUGERS, WATER-ROTARY AND CASING ADVANCER.
 4. MEASURING POINT ELEVATION - TOP OF INNER CASING.

PROJECT NO.: 6792-01		PROJECT NAME: MDNR - ORCHARD KNOLL		BORING/WELL NUMBER: GRS-2/MW-2		BOREHOLE DEPTH: 83 FT.	
DEPTH (FT.)	DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNTS(N)	PI METER	COMMENTS	WELL DATA
70	SANDSTONE - light gray, fine-medium grained, some mica, poorly graded, fractured, wet						
75						SAND FILTER PACK	
80						2-INCH 10-SLOT WIRE-WOUND STAINLESS-STEEL WELL SCREEN	
	END OF BORING AT 83 FEET						
85							

- NOTES: 1. SS - SOIL COLLECTED WITH A SPLIT-SPOON SAMPLER.
 2. ND - NOT DETECTED.
 3. "DRILLING METHOD" - 4.25-INCH ID HOLLOW-STEM AUGERS, WATER-ROTARY AND CASING ADVANCER.
 4. MEASURING POINT ELEVATION - TOP OF INNER CASING.

PROJECT NO.: 6792-01		PROJECT NAME: MDNR - ORCHARD KNOLL		BORING/WELL DESIGNATION: GRS-3/MW-3		BORING/WELL LOCATION:	
DRILLING CONTRACTOR: MATECO DRILLING CO.		DRILLING METHOD: SEE NOTES		BOREHOLE SIZE: 8 IN.		BOREHOLE DEPTH: 99 FT.	
DATE STARTED: 8/14/92		DATE COMPLETED: 8/23/92		GROUND ELEV.: 988.0 FT.		MEASURING POINT ELEV: 987.89 FT.	
RIG: CME-75		DRILLER: G. SAWYER		HELPER: T. GREEN		LOGGED BY: K. MISH	



DEPTH (FT.)	DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNTS(N)	P.I. METER	COMMENTS	WELL DATA
					(ppm)		
0	TOPSOIL					WELL COMPLETED AT GRADE WITH A FLUSH-MOUNT STEEL WELL PROTECTOR	
	SAND - light brown/brown, medium grained, trace coarse sand and gravel, poorly graded, loose, damp, occasional 1-4 inch coarse sand lenses present					CONCRETE	X X X X X X
5		4-6'	SS	2-3-4-6	ND		
10		9-11'	SS	3-4-5-6	ND	2-INCH FLUSH-THREADED GALVANIZED-STEEL RISER PIPE	
15		14-16'	SS	2-3-6-9	ND		
20		19-21'	SS	4-4-6-7	ND	CEMENT/BENTONITE GROUT	
25		24-26'	SS	4-6-8-12	ND		
30		29-31'	SS	6-10-10-10	ND		

- NOTES: 1. SS - SOIL COLLECTED WITH A SPLIT-SPOON SAMPLER.
 2. ND - NOT DETECTED.
 3. "DRILLING METHOD" - 4.25-INCH ID HOLLOW-STEM AUGERS, WATER-ROTARY, AND CASING ADVANCER.
 4. MEASURING POINT ELEVATION - TOP OF INNER CASING.
 5. "P.I. METER" - HEADSPACE SCREENING WITH A PHOTOIONIZATION METER, EXPRESSED IN PPM.

PROJECT NO.: 6792-01		PROJECT NAME: MDNR - ORCHARD KNOLL		BORING/WELL NUMBER: GRS-3/MW-3		BOREHOLE DEPTH: 99 FT.	
DEPTH (FT.)	DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNTS(N)	PI METER	COMMENTS	WELL DATA
30	SAND (continued)	29-31'	SS	6-10-10-10	ND		
35	CLAY - brown, little silt, stiff, damp	34-36'	SS	6-6-6-10	ND		
	CLAYEY SILT - gray, moist-wet						
	SAND - brown, fine-medium grained, trace coal, poorly graded, dense, moist-wet						
40		39-41'	SS	12-15-26-21	ND	2-INCH FLUSH-THREADED GALVANIZED-STEEL RISER PIPE	
	SAND - gray, fine-coarse grained, trace gravel, well graded, very loose, wet (groundwater at 44 feet)						
45		44-46'	SS	2-2-2-2	ND		
	SANDY GRAVEL - fine-coarse grained, trace silt and clay, well graded, wet						
50		49-51'	SS	4-4-6-50	ND		
	SAND - brown, medium grained, some coarse grained, trace gravel, poorly graded, medium dense, wet						
55		54-56'	SS	5-10-20-22	ND		
	SANDY GRAVEL - brown, sandstone fragments						
	GRAVEL - fine-coarse, some sand, silt and clay, dense, wet						
60		59-61'	SS	15-12-31-34	NR		
65		64-66'	SS	36-40-50-X	NR	CEMENT/BENTONITE GROUT	
	SANDSTONE - light gray, fine grained, micaceous, friable, fractured, wet, MARSHALL FORMATION	66-67.5'	SS	26-61-68	NR		
70		69-71'	SS	62-21-14-30	NR		

NOTES: 1. SS - SOIL COLLECTED WITH A SPLIT-SPOON SAMPLER.
 2. ND - NOT DETECTED.
 3. "DRILLING METHOD" - 4.25-INCH ID HOLLOW-STEM AUGERS, WATER-ROTARY AND CASING ADVANCER.
 4. NR - NOT RECORDED.
 5. X - SAMPLE REJECTION.

PROJECT NO.: 6792-01		PROJECT NAME: MDNR - ORCHARD KNOLL		BORING/WELL NUMBER: GRS-3/MW-3		BOREHOLE DEPTH: 99 FT.	
DEPTH (FT.)	DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNTS(N)	PI METER	COMMENTS	WELL DATA
70	SANDSTONE - light gray, fine-medium grained, some mica, friable, wet	69-71'	SS	62-21-14-30	NR		
		72.5- 73.5'	SS	100-70-X-X	NR		
75						DENSE BENTONITE SLURRY	
80						2-INCH FLUSH-THREADED GALVANIZED-STEEL RISER PIPE	
85							
90						SAND FILTER PACK	
95						2-INCH 10-SLOT WIRE-WOUND STAINLESS-STEEL WELL SCREEN	
100	END OF BORING AT 99 FEET						

- NOTES: 1. SS - SOIL COLLECTED WITH A SPLIT-SPOON SAMPLER.
 2. ND - NOT DETECTED.
 3. "DRILLING METHOD" - 4.25-INCH ID HOLLOW-STEM AUGERS, WATER-ROTARY AND CASING ADVANCER.
 4. NR - NOT RECORDED.
 5. X - SAMPLE REJECTION.

PROJECT NO.: 6792-01		PROJECT NAME: MDNR - ORCHARD KNOLL		BORING/WELL DESIGNATION: : GRS-4		BORING/WELL LOCATION:	
DRILLING CONTRACTOR: MATECO DRILLING CO.		DRILLING METHOD: SEE NOTES		BOREHOLE SIZE: 11 IN.		BOREHOLE DEPTH: 110 FT.	
DATE STARTED: 8/24/92		DATE COMPLETED: 9/03/92		GROUND ELEV.: - - FT.		MEASURING POINT ELEV: - - FT.	
RIG: CME-75		DRILLER: G. SAWYER		HELPER: T. GREEN		LOGGED BY: K. MISH	

DEPTH (FT.)	DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNTS(N)	PI METER	COMMENTS	WELL DATA
0	SAND - red/brown, medium grained, little coarse grained, trace fine gravel, loose, moist						NO WELL INSTALLED
5		4-6'	SS	3-3-3-4	ND		
10	SAND - light brown, medium grained, trace coarse sand and fine gravel, moderately sorted, loose, damp-moist	9-11'	SS	3-4-7-8	ND		
15		14-16'	SS	3-6-6-9	ND		
20		19-21'	SS	4-5-8-9	ND		
25		24-26'	SS	8-9-16-20	ND		
30	SANDY GRAVEL - brown, fine-coarse grained, trace cobbles	29-31'	SS	4-14-14-25	ND		

NOTES: 1. SS - SOIL COLLECTED WITH A SPLIT-SPOON SAMPLER.
 2. ND - NOT DETECTED.
 3. "DRILLING METHOD" - 8.25-INCH ID HOLLOW-STEM AUGERS AND WATER-ROTARY.
 4. "P.I. METER" - HEADSPACE SCREENING USING A PHOTOIONIZATION METER, EXPRESSED IN PPM.

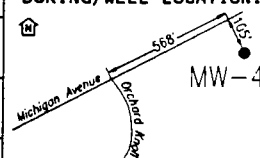
PROJECT NO.: 6792-01		PROJECT NAME: MDNR - ORCHARD KNOLL		BORING/WELL NUMBER: GRS-4		BOREHOLE DEPTH: 110 FT.	
DEPTH (FT.)	DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNTS(N)	PI METER	COMMENTS	WELL DATA
30	SANDY GRAVEL - brown, fine-coarse grained, trace silt, clay, and cobbles, moderately graded, wet	29-31'	SS	4-14-14-25	ND		
	SAND - brown, medium grained, trace coarse grained and gravel, poorly graded, medium dense, wet						
35	(groundwater at 34 feet)	34-36'	SS	3-6-6-11	ND		
	SAND - brown, coarse grained, some gravel, poorly graded, medium dense, wet						
40		39-41'	SS	5-5-8-8	ND		
45		44-46'	SS	3-3-4-5	NR		
	CLAYEY SILT - brown/gray, wet						
50	SILTY CLAY - gray, trace fine sand	49-51'	SS	4-5-5-10	ND		
	SAND - brown, medium grained, little fine gravel, loose, wet						
55		54-56'	SS	3-3-5-7	ND		
	SAND - brown, fine-medium grained, some silt and clay, trace gravel and cobbles, wet						
60		59-61'	SS	2-2-4-4	NR		
	SAND - gray, fine-medium grained, some gravel, trace silt and clay, moderately graded, loose, wet						
65		64-66'	SS	WOR-3-3-3	ND		
	CLAYEY SAND - gray, fine-medium grained, medium dense, wet						
70	BEDROCK AT 70 FEET						

NOTES: 1. SS - SOIL COLLECTED WITH A SPLIT-SPOON SAMPLER.
 2. ND - NOT DETECTED.
 3. "DRILLING METHOD" - 8.25-INCH ID HOLLOW-STEM AUGERS AND WATER-ROTARY.
 4. NR - NOT RECORDED.
 5. WOR - WEIGHT OF RODS.

PROJECT NO.: 6792-01		PROJECT NAME: MDNR - ORCHARD KNOLL		BORING/WELL NUMBER: GRS-4		BOREHOLE DEPTH: 110 FT.	
DEPTH (FT.)	DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNTS(N)	PI METER	COMMENTS	WELL DATA
70	SANDSTONE - light gray, very fine- fine grained, trace gravel and mica, highly friable, fractured, wet, MARSHALL FORMATION	69-71'	SS	15-15-13-26	ND		
75							
80							
85							
90							
95							
100							
105							
110	END OF BORING AT 110 FEET						

NOTES: 1. SS - SOIL COLLECTED WITH A SPLIT-SPOON SAMPLER.
 2. ND - NOT DETECTED.
 3. "DRILLING METHOD" - 8.25-INCH ID HOLLOW-STEM AUGERS AND WATER-ROTARY.

PROJECT NO.: 6792-01		PROJECT NAME: MDNR - ORCHARD KNOLL		BORING/WELL DESIGNATION: : GRS-4A/MW-4		BORING/WELL LOCATION:	
DRILLING CONTRACTOR: MATECO DRILLING CO.		DRILLING METHOD: SEE NOTES		BOREHOLE SIZE: 12 IN.		BOREHOLE DEPTH: 110 FT.	
DATE STARTED: 9/01/92		DATE COMPLETED: 9/03/92		GROUND ELEV.: 981.8 FT.		MEASURING POINT ELEV: 984.47 FT.	
RIG: CME-75		DRILLER: G. SAWYER		HELPER: T. GREEN		LOGGED BY: K. MISH	



DEPTH (FT.)	DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNTS(N)	PI METER	COMMENTS	WELL DATA
0	TOPSOIL					WELL COMPLETED ABOVE GROUND WITH A LOCKABLE WELL PROTECTOR	
	SAND - orange/brown, medium grained, little gravel, trace silt and clay, poorly graded, damp					CONCRETE	X X X X X X
5							
10	SAND - light brown, medium grained, trace coarse grained and fine gravel, damp					2-INCH FLUSH-THREADED GALVANIZED-STEEL RISER PIPE	
15							
20						CEMENT/ BENTONITE GROUT	
25	SAND - dark brown, fine-medium grained, trace gravel, silt and clay, damp-moist						
30							

NOTES: 1. SOIL DESCRIPTIONS LOGGED FROM CUTTINGS OFF AUGER FLIGHTS AND ROCK CORES.
 2. "DRILLING METHOD" - 8.25-INCH ID HOLLOW-STEM AUGERS AND ROCK CORING.
 3. MEASURING POINT ELEVATION - TOP OF INNER CASING.

PROJECT NO.: 6792-01

PROJECT NAME: MDNR - ORCHARD KNOLL

BORING/WELL NUMBER: MW-4

BOREHOLE DEPTH: 110 FT.

DEPTH (FT.)	DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNTS(N)	PI METER	COMMENTS	WELL DATA
30	SAND (continued)						
35						CEMENT/ BENTONITE GROUT	
40	GRAVELLY SAND - brown, fine-coarse grained, moist-wet						
45						2-INCH FLUSH-THREADED GALVANIZED-STEEL RISER PIPE	
50	NO RECOVERY FROM 50 FEET TO 67 FEET						
55							
60						DENSE BENTONITE SLURRY	
65							
70	GRAVELLY SAND - brown, medium-coarse grained, fine-coarse gravel, wet						

NOTES: 1. SOIL DESCRIPTIONS LOGGED FROM CUTTINGS OFF AUGER FLIGHTS AND ROCK CORING.
 2. "DRILLING METHOD" - 8.25-INCH ID HOLLOW-STEM AUGERS AND ROCK CORING.

PROJECT NO.: 6792-01		PROJECT NAME: MDNR - ORCHARD KNOLL		BORING/WELL NUMBER: MW-4		BOREHOLE DEPTH: 110 FT.	
DEPTH (FT.)	DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNTS(N)	PI METER	COMMENTS	WELL DATA
70	NO RECOVERY FROM 70 TO 84 FEET						
75						2-INCH FLUSH-THREADED GALVANIZED-STEEL RISER PIPE	
80	SANDSTONE - MARSHALL FORMATION						
85						INSTALL TEMPORARY CASING, REDUCED BOREHOLE DIAMETER FROM 12 INCHES TO 3 INCHES AT 84 FEET	
	SANDSTONE - light gray, fine-medium grained, micaceous, fractured, friable, wet					BOREHOLE CORED FROM 87 FEET TO 110 FEET	
90							
	SANDSTONE - light gray, fine grained, micaceous, friable, fractured, wet						
95						DENSE BENTONITE SLURRY	
100							
						SAND FILTER PACK	
105							
						2-INCH 10-SLOT WIRE-WOUND STAINLESS-STEEL WELL SCREEN	
110	END OF BORING AT 110 FEET						

NOTES: 1. SOIL DESCRIPTIONS LOGGED FROM CUTTINGS OFF AUGER FLIGHTS AND ROCK CORES.
2. "DRILLING METHOD" - 8.25-INCH ID HOLLOW-STEM AUGERS AND ROCK CORING.

APPENDIX B

**TECHNICAL MEMORANDUM NO. 2
MONITORING WELL GROUNDWATER SAMPLING AND ANALYSIS
ORCHARD KNOLL SITE INVESTIGATION**

TECHNICAL MEMORANDUM NO. 2

PROJECT: Orchard Knoll Site Investigation
SUBJECT: Groundwater Sampling and Analysis
PREPARED BY: Colleen M. Hart/ABB Environmental Services, Inc.

INTRODUCTION

The purpose of this technical memorandum is to describe the groundwater sampling and analysis conducted as Tasks 5 and 6 during the Orchard Knoll Site Preliminary Groundwater Contamination Assessment. This task was conducted by ABB Environmental Services, Inc. (ABB-ES) for the Michigan Department of Natural Resources (MDNR), Jackson District, under Contract No. 6624. Except as noted, the task was performed as described in the approved project Work Plan (May 1992) and Quality Assurance Project Plan (July 1992). Data gathered during these tasks were intended to provide a preliminary indication of the extent of groundwater contamination for the purpose of identifying the most-likely sources of groundwater contamination in the area.

SCHEDULE

All groundwater samples were collected on September 8, 1992.

PERSONNEL

During this effort, groundwater samples were collected by Colleen M. Hart (Scientist) and John P. McKenna (Associate Geologist), both of ABB-ES.

FIELD PROCEDURES

ABB-ES collected groundwater samples from four newly-installed monitoring wells after the new wells had been allowed to stabilize for at least one week following installation and development. Well locations are shown on Figure TM2-1. ABB-ES usually samples monitoring wells in order from the least contaminated to the most contaminated based on field observations made during installation. Because no contamination was observed during monitoring well installation, sampling was performed in numerical order (i.e., MW-1, -2, -3, and -4).

Before sampling, each well was checked for proper identification and location, and a photoionization (PI) meter was used to measure volatile organic chemicals (VOCs) at the wellhead and in ambient air. Ambient air was monitored before and after removing the well cap, and any differences in the two readings were noted. Using an electronic water level indicator, groundwater levels and well depths were then measured to the nearest 0.01 feet and recorded.

Based on the water level in the well, the volume of water standing inside the well casing was calculated, and the well was evacuated by removing at least three times that volume of groundwater. A Keck Model SP-84 stainless-steel submersible sampling pump with Teflon tubing was used to purge each well. Purging was accomplished by positioning the pump at the top of the standing water within the well casing and then slowly lowering the operating pump to the bottom to ensure that all stagnant water was removed from the well casing. After purging was completed, the pump was removed from the well, and the sample was collected using a stainless-steel bailer. At MW-3, a bend in the well casing would not allow the submersible pump to be lowered into the well. Therefore, MW-3 was purged and sampled using a disposable bailer. While evacuating each well, groundwater pH, temperature, and specific conductance were measured a minimum of three times using a Tri-Par three-function meter to check that stagnant water had been removed from the well.

Prior to initiating the sampling effort, a sampler blank (sample MW-201) was collected. The sampler blank was a laboratory-supplied deionized water sample handled and processed in the same manner as the groundwater samples (i.e., it was placed in the stainless-steel bailer and collected in sample vials). In addition, one blind duplicate sample (MW-101; duplicate of MW-2) was collected for submittal to the laboratory. One matrix spike and one matrix spike duplicate sample were also collected from MW-4. A trip blank (TB-01), supplied by the laboratory, also accompanied the sample shipment.

Groundwater samples from each of the monitoring wells were collected in two 40-milliliter, clear, glass bottles with Teflon-lined silicone septa (pre-preserved in the laboratory with hydrochloric acid). Each sample was labeled with the sample location (e.g., MW-2), date and time of sampling, sampler's initials, type of analysis required, ABB-ES' job number, and sample preservation. Each sample container was capped and tagged with a laboratory custody seal. Samples were placed in a cooler with ice for overnight delivery to Coast to Coast Laboratory (Valparaiso, Indiana) for analysis of VOCs using USEPA Methods 601 and 602. Chain-of-custody documentation was initiated by ABB-ES, and each sample was documented on ABB-ES' groundwater sample records (attached to this technical memorandum).

Down-hole purging and measuring equipment was decontaminated prior to sampling and between wells by pumping a solution of trisodium phosphate and distilled water through the pump, followed by a distilled water rinse. The outside of the pump and tubing were rinsed with a trisodium phosphate and distilled water solution, followed by

a distilled-water rinse. The stainless-steel bailer was decontaminated by washing with a solution of trisodium phosphate and distilled water followed by a deionized-water rinse.

RESULTS

Table TM2-1 summarizes water level elevation data for the four monitoring wells. Analytical results for the groundwater samples are summarized in Table TM2-2.

TABLE TM2-1
ORCHARD KNOLL SITE INVESTIGATION
WATER LEVEL DATA
SEPTEMBER 1992

WELL DESIGNATION	WELL DEPTH BELOW GROUND SURFACE (FT)	TOP OF CASING ELEVATION (FT)	DEPTH TO WATER SURFACE BELOW TOC (FT)	GROUNDWATER ELEVATION (9/8/92)
MW-1	95	976.26	31.19	945.07
MW-2	83	985.16	39.39	945.77
MW-3	99	987.89	42.23	945.66
MW-4	110	984.47	38.18	946.29

NOTES:

1. All elevations in feet referenced to an on-site survey benchmark and USGS datum.
2. All wells constructed of 2-inch-ID, flush-threaded, galvanized riser pipe and .010-inch slotted, 5-foot-long stainless-steel screen.

TABLE TM2-2
ORCHARD KNOLL INVESTIGATION
LABORATORY RESULTS FOR GROUNDWATER SAMPLES
AUGUST 1992

Sample Location:		MW-01	MW-02	MW-03	MW-101	MW-04	MW-201	TB-01
		Dup of MW-03				Sampler Blank		Trip Blank
<u>Volatile Organics</u>	<u>Units</u>							
1,1,1-Trichloroethane (TCA)	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2,2-Tetrachloroethane	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2-Trichloroethane	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichlorobenzene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane (EDC)	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloropropane	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
2-Chloroethylvinylether	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Bromodichloromethane	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromoform	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromomethane	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Carbon Tetrachloride	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chlorobenzene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloroethane	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Chloroform	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloromethane	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Methylene Chloride	µg/L	5 U	5 U	5 U	5 U	5 U	15	5 U
Tetrachloroethene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichloroethene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichlorofluoromethane	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Vinyl Chloride	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U
cis-1,3-Dichloropropene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,2-Dichloroethene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,3-Dichloropropene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichlorobenzene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Benzene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chlorobenzene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Xylenes	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U

Notes: U - Undetected. The analyte was analyzed for but not detected; the associated value shown is the Practical Quantitation Limit (PQL).
 - Contaminants detected are shaded.

GROUNDWATER SAMPLE RECORDS

GROUNDWATER SAMPLE RECORD

Page 1 of 1

SITE: MDNR- Orchard Knoll JOB NO. 6792-01 DATE: 9/8/92SAMPLE LOCATION MW-201 LAB NUMBER _____**BAILER SAMPLER BLANK**

WATER LEVEL/WELL DATA

MEASURED ☐ TOP OF WELL WELL DIAM. ☒ 2 INCH WATER DEPTH _____ FT MONITORING:
 WELL DEPTH _____ FT ☒ TOP OF CASING ☐ 4 INCH AMBIENT AIR _____ PPM
☐ _____ ☐ 6 INCH WELL MOUTH _____ PPM
☐ _____

HISTORICAL ☐ TOP OF WELL WELL MATERIAL: PROTECTIVE
 WELL DEPTH _____ FT ☒ TOP OF CASING ☐ PVC CASING STICK-UP
☐ _____ ☐ SS (FROM GROUND)
☐ _____ FT

PURGE DATA ☒ .16 GAL/FT (2 IN) PURGE TIME _____ SAMPLE TIME _____
 HEIGHT OF WATER ☐ .65 GAL/FT (4 IN) x 3.0 CASING = GALLONS TO BE START _____ START 11:35
 COLUMN _____ FT ☐ 1.5 GAL/FT (6 IN) VOLUMES PURGED END _____ END _____
☐ _____ GAL/FT (____ IN)

PURGE VOLUME a _____ GAL a _____ GAL a _____ GAL a _____ GAL a _____ GAL
 TEMP, DEG C _____
 pH, UNITS _____
 SPECIFIC CONDUCTIVITY, umhos/cm _____

EQUIPMENT DOCUMENTATION

PURGING	SAMPLING	EQUIPMENT ID	DECON FLUIDS USED	WATER LEVEL EQUIP. USED
<input checked="" type="checkbox"/>	<input type="checkbox"/> PERISTALTIC PUMP	<u>Keck-Cont</u>	<input type="checkbox"/> ETHYL ALCOHOL	<input checked="" type="checkbox"/> ELECTRIC COND. PROBE - <u>Solinst</u>
<input type="checkbox"/>	<input type="checkbox"/> SUBMERSIBLE PUMP		<input type="checkbox"/> DEIONIZED WATER	<input type="checkbox"/> FLOAT ACTIVATED
<input type="checkbox"/>	<input checked="" type="checkbox"/> BAILER (PVC/SS/TEFLON)		<input type="checkbox"/> HNO ₃ /D.I. WATER	<input type="checkbox"/> KECK INTERFACE PROBE
<input type="checkbox"/>	<input type="checkbox"/> PVC/SILICON TUBING		<input type="checkbox"/> POTABLE WATER	<input type="checkbox"/> OTHER
<input type="checkbox"/>	<input type="checkbox"/> TEFLON/SILICON TUBING		<input checked="" type="checkbox"/> TSP SOLUTION	
<input type="checkbox"/>	<input type="checkbox"/> AIR LIFT		<input type="checkbox"/> NONE	
<input type="checkbox"/>	<input type="checkbox"/> WATERA			NUMBER OF FILTER PAPERS USED _____
<input type="checkbox"/>	<input type="checkbox"/> IN-LINE FILTER			
<input type="checkbox"/>	<input type="checkbox"/> PRESS/VAC FILTER			

SAMPLES COLLECTED

BOTTLE ID	ANALYSIS REQUESTED	METHOD NUMBER	VOLUME	JAR TYPE	FILTERED	PRESERVATIVE/VOLUME
<u>MW-201</u>	<u>VOA</u>	<u>8010/8020</u>	<u>2x40ml</u>	<u>Glass</u>	<u>N</u>	<u>HCL</u>
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____

NOTES

SAMPLER BLANK TAKEN BY POURING
 LAB DI water into decontaminated SS Bailer.

GROUNDWATER SAMPLE RECORD

Page 1 of 1

SITE: MDNR- Orchard Knoll JOB NO. 6792-01 DATE: 9/8/92SAMPLE LOCATION MW-01 LAB NUMBER _____

WATER LEVEL/WELL DATA

MEASURED ☐ TOP OF WELL WELL DIAM. WATER DEPTH 31.19 FT MONITORING:
 WELL DEPTH 100 FT ☒ TOP OF CASING ☒ 2 INCH
☐ ☐ 4 INCH
☐ 6 INCH
☐ _____
 HISTORICAL ☐ TOP OF WELL WELL MATERIAL: PROTECTIVE
 WELL DEPTH 100 FT ☒ TOP OF CASING ☐ PVC CASING STICK-UP
☐ ☒ SS (FROM GROUND)
☐ _____ ☐ _____ FT

PURGE DATA ☒ .16 GAL/FT (2 IN) 33.0 PURGE TIME SAMPLE TIME
 HEIGHT OF WATER ☐ .65 GAL/FT (4 IN) x 3.0 CASING = 33.0 GALLONS TO BE START 11:17 START 11:53
 COLUMN 106.81 FT ☐ 1.5 GAL/FT (6 IN) VOLUMES PURGED END 11:50 END 11:56
☐ _____ GAL/FT (_____ IN)

PURGE VOLUME	a <u>6</u> GAL	a <u>12</u> GAL	a <u>18</u> GAL	a <u>24</u> GAL	a <u>30</u> GAL
TEMP, DEG C	<u>12.5</u>	<u>12.2</u>	<u>12.0</u>	<u>11.7</u>	<u>11.6</u>
pH, UNITS	<u>6.79</u>	<u>7.21</u>	<u>7.50</u>	<u>7.45</u>	<u>7.55</u>
SPECIFIC CONDUCTIVITY, umhos/cm	<u>904</u>	<u>900</u>	<u>899</u>	<u>897</u>	<u>908</u>

EQUIPMENT DOCUMENTATION

PURGING	SAMPLING	EQUIPMENT ID	DECON FLUIDS USED	WATER LEVEL EQUIP. USED
<input type="checkbox"/>	<input type="checkbox"/> PERISTALTIC PUMP		<input type="checkbox"/> ETHYL ALCOHOL	<input checked="" type="checkbox"/> ELECTRIC COND. PROBE-Solinst
<input checked="" type="checkbox"/>	<input type="checkbox"/> SUBMERSIBLE PUMP	<u>Keck</u>	<input type="checkbox"/> DETONIZED WATER	<input type="checkbox"/> FLOAT ACTIVATED
<input type="checkbox"/>	<input checked="" type="checkbox"/> BAILER (PVC/SS/TEFLON)		<input type="checkbox"/> HNO3/D.I. WATER	<input type="checkbox"/> KECK INTERFACE PROBE
<input type="checkbox"/>	<input type="checkbox"/> PVC/SILICON TUBING		<input type="checkbox"/> POTABLE WATER	<input type="checkbox"/> OTHER
<input type="checkbox"/>	<input type="checkbox"/> TEFLON/SILICON TUBING		<input checked="" type="checkbox"/> TSP SOLUTION	
<input type="checkbox"/>	<input type="checkbox"/> AIR LIFT		<input type="checkbox"/> NONE	
<input type="checkbox"/>	<input type="checkbox"/> WATERRA			NUMBER OF FILTER PAPERS USED _____
<input type="checkbox"/>	<input type="checkbox"/> IN-LINE FILTER			
<input type="checkbox"/>	<input type="checkbox"/> PRESS/VAC FILTER			
<input type="checkbox"/>	<input type="checkbox"/> _____			

SAMPLES COLLECTED

BOTTLE ID	ANALYSIS REQUESTED	METHOD NUMBER	VOLUME	JAR TYPE	FILTERED	PRESERVATIVE/VOLUME
<u>MW-1</u>	<u>VOA</u>	<u>8010/8020</u>	<u>2x40ml</u>	<u>Glass</u>	<u>N</u>	<u>HCl</u>
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____

NOTES

Well was purged by slowly lowering running pump down casing to insure evacuation of all stagnant water.

Water clear @ start of purge.

Pump rates \approx 1.0 gal/min.

Sample collected using SS Bailer

90303.WP
REVISED 3/90

SIGNATURE/FUNCTION: _____

ABB ENVIRONMENTAL SERVICES, INC.

GROUNDWATER SAMPLE RECORD

Page 1 of 1

SITE: MDNR - Orchard Knoll JOB NO. 6792-01 DATE: 9/8/92SAMPLE LOCATION MW-02 LAB NUMBER _____
Duplicate Taken

WATER LEVEL/WELL DATA

MEASURED 85.1 FT ☐ TOP OF WELL
WELL DEPTH 85.1 FT ☒ TOP OF CASING
☐ _____WELL DIAM.
☒ 2 INCH
☐ 4 INCH
☐ 6 INCH
☐ _____WATER DEPTH 39.39 FT

MONITORING:

AMBIENT AIR 0 PPM
WELL MOUTH 0 PPMHISTORICAL WELL DEPTH 85.1 FT ☐ TOP OF WELL
☒ TOP OF CASING
☐ _____WELL MATERIAL: PROTECTIVE
☐ PVC CASING STICK-UP
☒ SS (FROM GROUND)
☐ _____ 3 FT

PURGE DATA

PURGE DATA ☒ .16 GAL/FT (2 IN)
HEIGHT OF WATER ☐ .65 GAL/FT (4 IN)
COLUMN 45.71 FT ☐ 1.5 GAL/FT (6 IN)
☐ _____ GAL/FT (____ IN)x 3.0 CASING = 22.0
VOLUMES GALLONS TO BE
PURGEDPURGE TIME
START 12:54
END 13:16SAMPLE TIME
START 13:20
END 13:25

PURGE VOLUME

a 4 GALa 8 GALa 12 GALa 16 GALa 20 GAL

TEMP, DEG C

13.513.312.712.512.6

PH, UNITS

7.737.767.707.687.78

SPECIFIC CONDUCTIVITY, umhos/cm

960871923924924

EQUIPMENT DOCUMENTATION

PURGING

SAMPLING

EQUIPMENT ID

DECON FLUIDS USED

WATER LEVEL EQUIP. USED

☐ ☒ PERISTALTIC PUMP
☒ ☐ SUBMERSIBLE PUMP
☐ ☒ BAILER (PVC/SS/TEFLON)
☐ ☐ PVC/SILICON TUBING
☐ ☐ TEFLON/SILICON TUBING
☐ ☐ AIR LIFT
☐ ☐ WATERRA
☐ ☐ IN-LINE FILTER
☐ ☐ PRESS/VAC FILTER
☐ _____Keck

_____☐ ETHYL ALCOHOL
☐ DEIONIZED WATER
☐ HNO3/D.I. WATER
☐ POTABLE WATER
☒ TSP SOLUTION
☐ NONE
☐ _____☒ ELECTRIC COND. PROBE - Solinst
☐ FLOAT ACTIVATED
☐ KECK INTERFACE PROBE
☐ OTHER

NUMBER OF FILTER PAPERS USED _____

SAMPLES COLLECTED

BOTTLE ID	ANALYSIS REQUESTED	METHOD NUMBER	VOLUME	JAR TYPE	FILTERED	PRESERVATIVE/VOLUME
<u>MW-02</u>	<u>VOA</u>	<u>8010/8020</u>	<u>2x40ml</u>	<u>Glass</u>	<u>N</u>	<u>HCL</u>
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____

NOTES

Well was purged by slowly lowering pump down casing to evacuate all stagnant water.
Water clear @ start of purge.

Pump rate 2 1.0 gal/min

Sample collected using SS Bailer

SIGNATURE/FUNCTION: _____

90303.WP
REVISED 3/90

ABB ENVIRONMENTAL SERVICES, INC.

GROUNDWATER SAMPLE RECORD

Page 1 of 1

SITE: MDNR- Orchard Knoll JCS NO. 6792-01 DATE: 9/8/92SAMPLE LOCATION MW-101 LAB NUMBER _____
Duplicate MW-2

WATER LEVEL/WEEL DATA

MEASURED ☐ TOP OF WELL WELL DIAM. ☒ 2 INCH WATER DEPTH _____ FT MONITORING:
WELL DEPTH _____ FT ☒ TOP OF CASING ☐ 4 INCH AMBIENT AIR _____ PPM
☐ _____ ☐ 6 INCH WELL MOUTH _____ PPM
☐ _____

HISTORICAL ☐ TOP OF WELL WELL MATERIAL: PROTECTIVE
WELL DEPTH _____ FT ☒ TOP OF CASING ☐ PVC CASING STICK-UP
☐ _____ ☒ SS (FROM GROUND)
☐ _____ FT

PURGE DATA

☒ .16 GAL/FT (2 IN) PURGE TIME SAMPLE TIME
HEIGHT OF WATER ☐ .65 GAL/FT (4 IN) x3.0 CASING = GALLONS TO BE START _____ START 13:20
COLUMN _____ FT ☐ 1.5 GAL/FT (8 IN) VOLUMES PURGED END _____ END 13:25
☐ _____ GAL/FT (_____ IN)

PURGE VOLUME a _____ GAL a _____ GAL a _____ GAL a _____ GAL a _____ GAL
TEMP, DEG C _____
PH, UNITS _____
SPECIFIC CONDUCTIVITY, umhos/cm _____

EQUIPMENT DOCUMENTATION

PURGING	SAMPLING	EQUIPMENT ID	DECON FLUIDS USED	WATER LEVEL EQUIP. USED
<input type="checkbox"/>	<input type="checkbox"/> PERISTALTIC PUMP		<input type="checkbox"/> ETHYL ALCOHOL	<input checked="" type="checkbox"/> ELECTRIC COND. PROBE-Solinst
<input checked="" type="checkbox"/>	<input type="checkbox"/> SUBMERSIBLE PUMP	<u>Keck</u>	<input type="checkbox"/> DEIONIZED WATER	<input type="checkbox"/> FLOAT ACTIVATED
<input type="checkbox"/>	<input checked="" type="checkbox"/> BAILER (PVC/SS/TEFLON)		<input type="checkbox"/> HNO3/D.I. WATER	<input type="checkbox"/> KECK INTERFACE PROBE
<input type="checkbox"/>	<input type="checkbox"/> PVC/SILICON TUBING		<input type="checkbox"/> POTABLE WATER	<input type="checkbox"/> OTHER
<input type="checkbox"/>	<input type="checkbox"/> TEFLON/SILICON TUBING		<input checked="" type="checkbox"/> TSP SOLUTION	
<input type="checkbox"/>	<input type="checkbox"/> AIR LIFT		<input type="checkbox"/> NONE	NUMBER OF FILTER PAPERS USED _____
<input type="checkbox"/>	<input type="checkbox"/> WATERA			
<input type="checkbox"/>	<input type="checkbox"/> IN-LINE FILTER			
<input type="checkbox"/>	<input type="checkbox"/> PRESS/VAC FILTER			
<input type="checkbox"/>	<input type="checkbox"/>			

SAMPLES COLLECTED

BOTTLE ID	ANALYSIS REQUESTED	METHOD NUMBER	VOLUME	JAR TYPE	FILTERED	PRESERVATIVE/VOLUME
<u>MW-101</u>	<u>VOA</u>	<u>8010/8020</u>	<u>2x40ml</u>	<u>Glass</u>	<u>N</u>	<u>HCL</u>
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____

NOTES

SS. Duplicate TAKEN USING SS. Bailer

GROUNDWATER SAMPLE RECORD

Page 1 of 1

SITE: MDNR- Orchard Knoll JOB NO. 6792-01 DATE: 9/8/92SAMPLE LOCATION MW-03

LAB NUMBER _____

WATER LEVEL/WEEL DATA

MEASURED
WELL DEPTH 96 FT ☐ TOP OF WELL
☒ TOP OF CASINGWELL DIAM.
☒ 2 INCH
☐ 4 INCH
☐ 6 INCH
☐ _____WATER DEPTH 42.23 FT

MONITORING:

AMBIENT AIR ☒ PPM
WELL MOUTH ☒ PPMHISTORICAL
WELL DEPTH 96 FT ☐ TOP OF WELL
☒ TOP OF CASINGWELL MATERIAL: PROTECTIVE
☐ PVC CASING STICK-UP
☒ SS (FROM GROUND)
☐ _____ FTPURGE DATA ☒ .16 GAL/FT (2 IN)HEIGHT OF WATER ☐ .65 GAL/FT (4 IN)COLUMN 53.77 FT ☐ 1.5 GAL/FT (6 IN)
☐ _____ GAL/FT (____ IN)x 3.0 CASING = 26.0
VOLUMES GALLONS TO BE
PURGEDPURGE TIME
START 13:40
END 13:10SAMPLE TIME 13:12
START 13:12
END 13:14
entPURGE VOLUME a 5 GAL a 10 GAL a 15 GAL a 20 GAL a 25 GAL

TEMP, DEG C _____

pH, UNITS _____

SPECIFIC CONDUCTIVITY, umhos/cm. _____

EQUIPMENT DOCUMENTATION

PURGING	SAMPLING	EQUIPMENT ID	DECON FLUIDS USED	WATER LEVEL EQUIP. USED
<input checked="" type="checkbox"/>	<input type="checkbox"/> PERISTALTIC PUMP	<u>Keck</u>	<input type="checkbox"/> ETHYL ALCOHOL	<input checked="" type="checkbox"/> ELECTRIC COND. PROBE-Solinst
<input checked="" type="checkbox"/>	<input type="checkbox"/> SUBMERSIBLE PUMP	_____	<input type="checkbox"/> DEIONIZED WATER	<input type="checkbox"/> FLOAT ACTIVATED
<input type="checkbox"/>	<input checked="" type="checkbox"/> BAILER (PVC/SS/TEFLON)	_____	<input type="checkbox"/> HNO3/D.I. WATER	<input type="checkbox"/> KECK INTERFACE PROBE
<input type="checkbox"/>	<input type="checkbox"/> PVC/SILICON TUBING	_____	<input type="checkbox"/> POTABLE WATER	<input type="checkbox"/> OTHER
<input type="checkbox"/>	<input type="checkbox"/> TEFLON/SILICON TUBING	_____	<input checked="" type="checkbox"/> TSP SOLUTION	NUMBER OF FILTER PAPERS USED _____
<input type="checkbox"/>	<input type="checkbox"/> AIR LIFT	_____	<input type="checkbox"/> NONE	
<input type="checkbox"/>	<input type="checkbox"/> WATERA	_____		
<input type="checkbox"/>	<input type="checkbox"/> IN-LINE FILTER	_____		
<input type="checkbox"/>	<input type="checkbox"/> PRESS/VAC FILTER	_____		

SAMPLES COLLECTED

BOTTLE ID	ANALYSIS REQUESTED	METHOD NUMBER	VOLUME	JAR TYPE	FILTERED	PRESERVATIVE/VOLUME
<u>MW-03</u>	<u>VOA</u>	<u>8010/8020</u>	<u>2x40ml</u>	<u>Glass</u>	<u>N</u>	<u>HCL</u>
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____

NOTES well purged using disposable bailer

GROUNDWATER SAMPLE RECORD

Page 1 of 1

SITE: MDNR- Orchard Knoll JOB NO. 6792-01 DATE: 9/8/92SAMPLE LOCATION MW-04 LAB NUMBER _____MS/MSD TAKEN

WATER LEVEL/WELL DATA

MEASURED
WELL DEPTH 110 FT ☒ TOP OF WELL
☒ TOP OF CASING
☐ _____WELL DIAM.
☒ 2 INCH
☐ 4 INCH
☐ 6 INCH
☐ _____WATER DEPTH 38.18 FT

MONITORING:

AMBIENT AIR 0 PPM
WELL MOUTH 0 PPMHISTORICAL
WELL DEPTH 110 FT ☐ TOP OF WELL
☒ TOP OF CASING
☐ _____WELL MATERIAL: PROTECTIVE
☐ PVC CASING STICK-UP
☒ SS (FROM GROUND)
3.0 FT

PURGE DATA

HEIGHT OF WATER COLUMN 11.82 FT
☒ .16 GAL/FT (2 IN)
☐ .65 GAL/FT (4 IN)
☐ 1.5 GAL/FT (6 IN)
☐ _____ GAL/FT (____ IN)x 3.0 CASING = 34.0 GALLONS TO BE
VOLUMES PURGED

PURGE TIME

START 14:10
END 14:45

SAMPLE TIME

START 15:26
END 15:33

PURGE VOLUME

a 6 GALa 12 GALa 18 GALa 24 GALa 30 GAL

TEMP, DEG C

13.412.812.312.8412.2

pH, UNITS

7.777.647.707.577.56

SPECIFIC CONDUCTIVITY, umhos/cm

1016963954951949

EQUIPMENT DOCUMENTATION

PURGING

SAMPLING

EQUIPMENT ID

DECON FLUIDS USED

WATER LEVEL EQUIP. USED

☐ ☐ PERISTALTIC PUMP
☒ ☐ SUBMERSIBLE PUMP
☐ ☒ BAILER (PVC/SS/TEFLON)
☐ ☐ PVC/SILICON TUBING
☐ ☐ TEFLON/SILICON TUBING
☐ ☐ AIR LIFT
☐ ☐ WATERRA
☐ ☐ IN-LINE FILTER
☐ ☐ PRESS/VAC FILTER
☐ _____Keck☐ ETHYL ALCOHOL
☐ DEIONIZED WATER
☐ HNO3/D.I. WATER
☒ POTABLE WATER
☒ TSP SOLUTION
☐ NONE
☐ _____☒ ELECTRIC COND. PROBE-Solinst
☐ FLOAT ACTIVATED
☐ KECK INTERFACE PROBE
☐ OTHER

NUMBER OF FILTER PAPERS USED _____

SAMPLES COLLECTED

BOTTLE ID	ANALYSIS REQUESTED	METHOD NUMBER	VOLUME	JAR TYPE	FILTERED	PRESERVATIVE/VOLUME
<u>MW-04</u>	<u>VOA</u>	<u>8010/8020</u>	<u>2x40ml</u>	<u>Glass</u>	<u>N</u>	<u>HCL</u>
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____

NOTES

Well purged by slowly lowering pump down casing to ensure all stagnate water was evacuated.

Pump rate a 1.0 gal/min

Sampled using SS. Bailer

Clean & start of purge.

SIGNATURE/FUNCTION: _____

ABB ENVIRONMENTAL SERVICES, INC.

GROUNDWATER SAMPLE RECORD

Page 1 of 1

SITE: MDNR- Orchard Knoll JOB NO. 6792-01 DATE: 9/8/92SAMPLE LOCATION ~~FW~~ ^{cmh} TB-01 LAB NUMBER _____

WATER LEVEL/WELL DATA

MEASURED	<input type="checkbox"/> TOP OF WELL	WELL DIAM.	WATER DEPTH _____ FT	MONITORING:
WELL DEPTH _____ FT	<input checked="" type="checkbox"/> TOP OF CASING	<input checked="" type="checkbox"/> 2 INCH		AMBIENT AIR _____ PPM
	<input type="checkbox"/> _____	<input type="checkbox"/> 4 INCH		WELL MOUTH _____ PPM
		<input type="checkbox"/> 6 INCH		
		<input type="checkbox"/> _____		
HISTORICAL	<input type="checkbox"/> TOP OF WELL	WELL MATERIAL:	PROTECTIVE	
WELL DEPTH _____ FT	<input checked="" type="checkbox"/> TOP OF CASING	<input type="checkbox"/> PVC	CASING STICK-UP	
	<input type="checkbox"/> _____	<input type="checkbox"/> SS	(FROM GROUND)	
		<input type="checkbox"/> _____	_____ FT	

PURGE DATA	<input checked="" type="checkbox"/> .16 GAL/FT (2 IN)		PURGE TIME	SAMPLE TIME
HEIGHT OF WATER	<input type="checkbox"/> .65 GAL/FT (4 IN)	x <u>3.0</u> CASING	START _____	START <u>15:50</u>
COLUMN _____ FT	<input type="checkbox"/> 1.5 GAL/FT (6 IN)	VOLUMES	END _____	END _____
	<input type="checkbox"/> _____ GAL/FT (____ IN)			

PURGE VOLUME	@ _____ GAL	@ _____ GAL	@ _____ GAL	@ _____ GAL	@ _____ GAL
TEMP, DEG C	_____	_____	_____	_____	_____
pH, UNITS	_____	_____	_____	_____	_____
SPECIFIC CONDUCTIVITY, umhos/cm	_____	_____	_____	_____	_____

EQUIPMENT DOCUMENTATION

PURGING	SAMPLING	EQUIPMENT ID	DECON FLUIDS USED	WATER LEVEL EQUIP. USED
<input type="checkbox"/>	<input type="checkbox"/> PERISTALTIC PUMP		<input type="checkbox"/> ETHYL ALCOHOL	<input checked="" type="checkbox"/> ELECTRIC COND. PROBE-Solinst
<input checked="" type="checkbox"/>	<input type="checkbox"/> SUBMERSIBLE PUMP	<u>Keck</u>	<input type="checkbox"/> DEIONIZED WATER	<input type="checkbox"/> FLOAT ACTIVATED
<input type="checkbox"/>	<input checked="" type="checkbox"/> BAILER (PVC/SS/TEFLON)		<input type="checkbox"/> HNO ₃ /D.I. WATER	<input type="checkbox"/> KECK INTERFACE PROBE
<input type="checkbox"/>	<input type="checkbox"/> PVC/SILICON TUBING		<input type="checkbox"/> POTABLE WATER	<input type="checkbox"/> OTHER
<input type="checkbox"/>	<input type="checkbox"/> TEFLON/SILICON TUBING		<input checked="" type="checkbox"/> TSP SOLUTION	
<input type="checkbox"/>	<input type="checkbox"/> AIR LIFT		<input type="checkbox"/> NONE	
<input type="checkbox"/>	<input type="checkbox"/> WATERRA			NUMBER OF FILTER PAPERS USED _____
<input type="checkbox"/>	<input type="checkbox"/> IN-LINE FILTER			
<input type="checkbox"/>	<input type="checkbox"/> PRESS/VAC FILTER			
<input type="checkbox"/>	<input type="checkbox"/> _____			

SAMPLES COLLECTED

BOTTLE ID	ANALYSIS REQUESTED	METHOD NUMBER	VOLUME	JAR TYPE	FILTERED	PRESERVATIVE/VOLUME
<u>FW TB-01</u>	<u>VOA</u>	<u>8010/8020</u>	<u>2x40ml</u>	<u>Glass</u>	<u>N</u>	<u>HCL</u>
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____

NOTES

SIGNATURE/FUNCTION: _____



**ABB Environmental Services
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